

[COMMITTEE PRINT]

THE NEED FOR AN INCREASED SPACE SHUTTLE
ORBITER FLEET

REPORT

PREPARED BY THE

SUBCOMMITTEE ON
SPACE SCIENCE AND APPLICATIONS

TRANSMITTED TO THE

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SCIENCE AND TECHNOLOGY
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CONTENTS

	<i>Page</i>
I. Introduction	1
II. Summary of Witness Testimony.....	3
III. Major Issues Addressed in the Hearing.....	12
Is a Fifth Orbiter Necessary?.....	12
Who Should Finance the Fifth Orbiter?.....	17
When Should We Build the Fifth Orbiter?.....	20
Is Legislation Required in Order for the Private Sector to Assume Ownership and Operation of the Fifth Orbiter?.....	21
How Do We Make the Space Transportation System Competitive?...	22
IV. Conclusions and Recommendations.....	26

(III)

LETTER OF SUBMITTAL

HOUSE OF REPRESENTATIVES,
COMMITTEE ON SCIENCE AND TECHNOLOGY,
Washington, D.C., December 1982.

HON. DON FUQUA,
*Chairman, Committee on Science and Technology,
U.S. House of Representatives.*

DEAR MR. CHAIRMAN: I am forwarding herewith this report on the Need for an Increased Space Shuttle Orbiter Fleet based on a hearing held June 15, 1982.

Throughout the FY 1983 NASA Authorization hearings, a number of witnesses who testified before the Subcommittee on Space Science and Applications stated that a four orbiter fleet would not adequately serve the projected space traffic requirements for the late 1980's. To guarantee a fifth orbiter delivery price around \$1 billion, NASA must soon commit to procurement of long-lead items. It is essential for NASA to expedite this decision since many third tier sub-contractors are completing their Shuttle-related work.

This document reflects the continuing interest and concern of the Subcommittee for an effective National Space Transportation System. Many have contributed to the development of this report; Mr. J. Jeffrey Irons of the Committee staff and Dr. Gordon A. Smith, AIAA Congressional Fellow, played key roles in its development. This report summarizes the testimony, which is published as a separate document, and offers findings and recommendations based on the testimony.

Sincerely,

RONNIE G. FLIPPO,
*Chairman, Subcommittee on
Space Science and Applications.*

I. INTRODUCTION

The Subcommittee on Space Science and Applications, one of seven subcommittees of the Committee on Science and Technology, works each year on the annual authorization of appropriations for the National Aeronautics and Space Administration (NASA). In recent years, a major portion of NASA's budget has been spent on developing the reusable Space Transportation System. As the system begins its transition from developmental to operational status, a number of issues have emerged that require review by the Subcommittee. One of the most important and overriding issues is the need for additional orbiters for the Space Transportation fleet. This report deals specifically with that issue.

In order to fully understand all points of view, the Subcommittee on Space Science and Applications held a hearing June 15, 1982 to examine the issues associated with the need for increasing the size of the Space Shuttle orbiter fleet.

In the legislative report accompanying the FY 1982 authorization bill (Report No. 97-32), the Committee requested that NASA and the Air Force review the requirements for additional orbiter vehicles and submit the results of this review to the Congress in December 1981. Unfortunately, this review was not completed in time for consideration during the FY 1983 annual authorization process.

A second, related objective of the hearing was to examine a concept which has been proposed by the Space Transportation Company, Inc. (SpaceTran) whereby the procurement of the fifth orbiter vehicle would be financed through investments from the private sector. SpaceTran was formed in 1979 with the express purpose of determining whether the private ownership and operation of a fifth Space Shuttle orbiter would be economically feasible. SpaceTran has received partial financial backing and support from the Prudential Insurance Company of America. In February 1982, SpaceTran submitted a proposal to NASA to procure an orbiter in exchange for exclusive marketing rights of foreign and commercial payloads aboard this vehicle. SpaceTran subsequently sent NASA a revised proposal in May. In commenting on this approach, Chairman Flippen said at the hearing:

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... while I do not want to prejudge the agency's assessment of this proposal, decisions must be made in a timely manner to assure full public discussion and Congressional review.

Congressman Hollenbeck, Ranking Republican Member of the Subcommittee, summarized his concerns about a timely decision to procure a fifth orbiter and the SpaceTran proposal, as follows:

... we are at a crossroads for our Subcommittee: Subcontractors running out of Shuttle work, no funds requested by the Administration in FY 1983 for a fifth orbiter, NASA now telling us they need more than a four orbiter fleet, and a proposal by an insurance company-backed organization to buy the fifth shuttle. All of these issues are related since we must decide now whether to go ahead and build a fifth orbiter, and if we do so, should we consider private financing?

The Subcommittee attempted to examine fully the issues associated with the need for additional Space Shuttle orbiters. Witnesses from within the Administration, the American Institute of Aeronautics and Astronautics, Boeing Aerospace Company, SpaceTran, and Prudential Insurance testified on the requirements for a fifth or additional orbiters; the feasibility and timing of the SpaceTran proposal; military and civilian launch requirements through the late 1980's; and the ability of the reusable Space Transportation System to adequately support both civil and national security missions.

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II. SUMMARY OF WITNESS TESTIMONY

The witnesses who testified before the Subcommittee to consider the requirements for increasing the size of the Space Shuttle orbiter fleet represented a mix of government, private sector, and technical society officials. The witness list follows:

Mr. Philip E. Culbertson
Associate Deputy Administrator
National Aeronautics and Space
Administration

Accompanied by:

Major General J. A. Abrahamson
Associate Administrator
Office of Space Transportation Systems
NASA

Dr. Stanley I. Weiss
Associate Administrator
Office of Space Transportation Operations
NASA

Hon. Edward C. Aldridge
Under Secretary of the Air Force
Department of the Air Force

Accompanied by:

Dr. Charles W. Cook
Deputy Assistant Secretary
(Space Plans & Policy)

Brig. General Bernard P. Randolph,
Director of Space Systems and Command,
Control and Communications

Dr. Jerry Grey
Administrator for Public Policy
American Institute of Aeronautics and Astronautics

Dr. Robert L. Brock
Vice President & Deputy for Strategy Planning
and Acquisition
Space and Information Systems
Boeing Aerospace Company

Accompanied by:

Mr. Gilbert W. Keyes, Director
International Space Sales
Boeing Aerospace Company

Dr. Klaus P. Heiss
President
Space Transportation Company, Inc.

Mr. William S. Field, C.L.U.
Space Transportation Board and
Senior Vice President
Capital Markets Department
Prudential Insurance Company
of America, Inc.

The following is a brief summary of each witness' testimony:

NASA

Philip E. Culbertson. Mr. Culbertson testified that "past discussions on the need for additional orbiters have centered on two points: the impact on meeting the payload launch demands of the Government and other users (both domestic and international) when there is unscheduled orbiter downtime for repair and maintenance--or loss from service due to attrition; and the need for a sufficient level of flight capability to meet the projected traffic model for the last half of the 1980's and beyond."

Attrition and unscheduled maintenance of any one of the four orbiters will not justify additional orbiters for NASA since "NASA is planning to operate the Space Shuttle fleet at least through 1987 with a maximum of four orbiters. The current flight rate planning has the rate reaching 24 flights per year by 1988. Based on our current turnaround projections, the four orbiter fleet will be capable of accomplishing the 24 flights per year rate and should be able to meet peak rates of close to 30 flights per year."

Orbiter loss, however, would represent a major impact on the STS program, especially to the civilian space program. "...If the four orbiter fleet were reduced to three orbiters in 1986 due to the loss of an orbiter, we estimate that the effective flight rate capacity of the space transportation system would be reduced by about eight flights per year. Because the Space Shuttle's launch availability would be reduced--in some years by one third of the planned flight rate,

meeting the Department of Defense requirements for launch dates, assuming expendable vehicles are unavailable, would involve preemption of civilian missions. While the priority assigned to Department of Defense missions makes this both desirable and necessary, such a preemption would involve additional costs and program impacts to civilian users."

Mr. Culbertson summarized NASA's activities in preserving the fifth orbiter procurement option. "We are examining a full spectrum of issues relating to safeguards against orbiter attrition and stand downs, fleet size economics, and production continuity. The Administration's policy deliberations are addressing these issues in the context of selecting the most appropriate and prudent approach to meeting the future launch requirements of civil and defense systems. It is clear that we need to consider most carefully the desirability of procuring additional capacity for the Space Shuttle at this time in light of the significant budget implications. Other avenues to increasing the launch capacity--such as further reducing the turnaround times--have to be taken into account. We need to determine the role of expendable launch vehicles for the future, and whether they offer a reasonable means of satisfying the launch assurance requirements of the Department of Defense and certain other users as well as meet launch traffic demands the Shuttle cannot satisfy."

U.S. Air Force

Honorable Edward C. Aldridge, Mr. Aldridge described the Air Force position with regard to the need for the fifth orbiter: "...we support the procurement of a fifth orbiter and the provision for addition procurements, as needed. Production of a fifth orbiter will:

- "- Significantly augment the capability of the four orbiter fleet.
- "- Provide a continued production capability until the ultimate fleet size is determined.
- "- Provide a sustained logistics support production base."

This position is based "upon the belief that the Nation, if it is to totally commit both essential defense and civil missions to the Shuttle, must retain some confidence in the continued operational capability of the system. That confidence requires that the system be able to tolerate some level of attrition without undue disruption. It also requires that the early operational period be allowed to progress without foreclosing on the opportunity to exploit what we learn through a better orbiter."

Mr. Aldridge commented as follows on private sector investment in the STS: "It is in the long-range interest of the U.S. to encourage participation in space activities by private interests. Since procurement of a fifth orbiter would be in the best National Interest, it is appropriate to consider commercial proposals which might take some of the burden from the taxpayer."

"While we are interested in the idea of commercial procurement of an orbiter, we cannot give an unqualified endorsement because we do not fully understand the advantages and limitations that such a concept would impose. In the meantime, we would ask that Congress maintain the funding of NASA for a fifth orbiter as a means of insuring the availability of that vehicle."

American Institute of Aeronautics and Astronautics

Dr. Jerry Grey. Dr. Grey, reiterating testimony before the Subcommittee on March 19, 1981, said: "The Administrator's proposal to reduce funding for the fifth Shuttle orbiter...and to limit the procurement of expendable launchers would result in a direct and substantial economic loss to the U.S."

Dr. Grey proceeded to draw extensively from the AIAA's position that had been fully documented in "Projection of Non-Federal Demand for Space Transportation Services through 2000," an AIAA Assessment for the Office of Science and Technology Policy, the White House, published January 19, 1981. The main points of that report, germane to this discussion, were: "the projected space transportation system will by itself be unable to meet projected user demand through at least the latter portion of the 1980's, even if none of the (projected) non-federal demand materializes in the advanced technology sectors."

"This projected supply-demand gap is very likely to be exacerbated by the initial Shuttle space transportation system operational problems which are certain to be encountered, as with any new, complex system, based on past experience with similar advanced-technology flight systems."

"Additional space transportation system capability will be needed to relieve schedule and capacity constraints which appear to be imposed by limited numbers of Space Shuttle orbiters and mobile launch platforms and by the capacity of certain facilities at the Kennedy Space Center."

Dr. Grey emphasized that these statements had been reinforced by the growth in demand for launch capabilities. This growth had been stimulated by the proliferation, worldwide,

of communications technology, enhanced space processing prospects, and the escalation of military space activities. In view of this situation, the AIAA believes that: "As long as Shuttle space availability is constrained, as it will be for at least the next four or five years, Arianespace will siphon off much if not most of the new launch business accompanying the explosive demand growth for commercial space systems. And unless steps are taken today to increase Shuttle availability after the initial four or five year phase, the loss of business to Ariane and to the increasing Japanese launch vehicle capability will cripple the Shuttle's marketability well into the future."

To help alleviate this situation, Dr. Grey repeated previous AIAA recommendations that include: "Initiate construction of a fifth orbiter, not only for its capacity to meet launch demand but also to keep the production line intact if (or when, according to the January 1981 AIAA projection) the need for sixth and subsequent orbiters becomes evident."

"Continue to produce expendable launchers until the Shuttle system has proved its ability to satisfy the launch demand."

"Initiate development of a high-performance upper stage to take full advantage of the Shuttle's truly remarkable and unique capabilities."

In conclusion, Dr. Grey suggested that: "An innovative pricing and roles policy must be instituted for commercial and foreign customers to meet the 'fly now, pay later' plan offered by Arianespace."

Boeing Aerospace Company

Dr. Robert L. Brock. Dr. Brock, addressed the following issues: whether additional orbiters are required for an effective Space Transportation System; the proposal by the private sector to purchase a fifth orbiter; and the results of a Boeing study on the proposed private operation of the Space Shuttle system. The conclusions that Boeing drew from consideration of these issues were:

"A fifth orbiter will be needed if the Space Transportation System is to proceed logically to the point where it is economically attractive to the commercial users who are needed to assure its success."

"It is feasible for the private sector to buy the fifth orbiter--as long as there are adequate safeguards both for the organization which purchases it and for the public which will depend upon it."

"Private operation of the Space Shuttle system can be commercially rewarding, but data to support this conclusion are, at this moment, not conclusive."

In 1977, NASA commissioned Boeing to study alternative methods of Shuttle operations, and Dr. Brock described the background and conclusions of the study. Boeing chose three approaches for evaluation:

"In the first, the company formed would have the franchise for all planned Space Shuttle launches. In the second, its responsibility would embrace all non-military launches but would include all other government missions. In the third, the proposed company would be limited to the franchise for all commercial and foreign launches only."

In proceeding with the study, Boeing assumed that the proposed company would purchase a fifth orbiter and receive a time-limited franchise for the space launch responsibility. Further assumptions were:

- "1. That NASA's 1977-78 traffic forecast and pricing policy were accurate.
- "2. That NASA's 1977-78 forecast operations costs were correct.
- "3. That the yet-to-be flown Space Shuttle would meet its objectives, including turnaround times, orbiter costs, load factors, and the like."

Based on these assumptions, it was concluded that all three study options showed an attractive return on investment. However, it would take an unacceptable length of time for a new company to become profitable if it assumed the entire Shuttle operation and, Dr. Brock continued, a consortium approach would have been required for the following reasons:

- "1. We felt it would be politically unacceptable for a single company to be granted the fruits of years of public efforts and billions of taxpayers dollars.
- "2. The necessary investment was too great for one existing company.
- "3. The financial risk was too great for one company to assume."

Dr. Brock, emphasized that the study's conclusions were dependent on the assumptions that had been made. He then concluded with an update on the status of the Inertial Upper Stage (IUS) development. Dr. Brock cautioned that:

"A major impediment to this development is the uncertainty of Shuttle payload costs. If the IUS-Shuttle combination costs the same or less per pound of payload as Ariane 4, there may be a very large market. If the cost is significantly higher, we very well could lose out to the European launch vehicle."

Space Transportation Company, Inc.

Dr. Klaus P. Heiss. Dr. Heiss is President of the Space Transportation Company (SpaceTran) Inc. located in Princeton, New Jersey. He described the company's origin, as follows: "SpaceTran was formed in 1979 for the purpose of determining whether the private ownership and operation of a fifth orbiter would be economically feasible."

SpaceTran testified that there is a need for a fifth Space Shuttle, and the U.S. would benefit from the added capacity to the National Space Transportation System for the following reasons:

"First, the ability to meet the growth in demand for the commercial and foreign users; second, the assurance that the United States can compete effectively with Arianespace; third, a hedge against any catastrophic losses or operational difficulties of the first four orbiters; fourth, an increased presence of United States aerospace capabilities in world markets and an improvement of the Nation's balance of payments; and fifth, more cost effective Shuttle operations due to technological improvements in Orbiter V and subsequent orbiters."

Dr. Heiss stated that the following considerations argue in favor of private funding for the fifth orbiter:

"First, if a project or activity can be funded by the private sector rather than through the use of taxpayers' funds, there appears to be a consensus today, in view of large Federal budget deficits, that private funding is preferred.

"Second, private funding of this magnitude in space transportation would be proof of the maturation of the United States space effort as a prelude to the commercial development of space and space technology. In our opinion, the introduction of private capital to supplement Government funding is critical to sustain space industrialization.

"Third, private funding of Orbiter V would facilitate potential private financing of additional orbiters for commercial and foreign uses, or for that matter, of any other components of the Space Transportation System.

"Fourth, the example set by the Europeans in creating Arianespace - a private company with business incentives, objectives, and techniques - has been singularly successful. We believe that SpaceTran, under private ownership with substantial capital at risk, can match the marketing efforts of Arianespace, or other foreign competition."

The nature of the SpaceTran proposal follows:

"First, to purchase Orbiter V with private funds raised in the United States; second, to contract for all commercial and foreign uses of Orbiter V; third, to contract with NASA for launch support services; and fourth, to make Orbiter V available to the Department of Defense whenever an emergency use is required.

"Under our (May 17, 1982) proposal, SpaceTran does not seek from NASA any exclusive arrangement to fund additional orbiters or to market commercial and foreign payloads."

Prudential Insurance Company of America, Inc.

William S. Field. Mr. Field presented Prudential's relationship with SpaceTran and his view on the need for the fifth orbiter:

"On March 23, 1982, the Board of Directors of Prudential authorized an equity investment in SpaceTran, which we view as a venture capital investment. The initial funds invested by Prudential will be used to evaluate the feasibility of a large scale private sector funding of Orbiter V."

Prudential believes that there are two major obstacles that must be resolved before the company can commit itself to the full capital cost of the fifth orbiter:

"The first is the question of whether agreement can be reached with the Government, without the need for legislation and on the terms and conditions of a contract whereby SpaceTran could operate a fifth orbiter as a business venture, subject to risks that are no greater than those generally borne by commercial enterprises. These conditions deal with such issues, for example, as being assured that SpaceTran's orbiter could, in fact, be launched and that, indeed, there would be a U.S. Space Transportation System in which to use it.

"The second has to do with the actual demand for Space Shuttle flights by commercial and foreign users. Key considerations are knowledge of what launch costs to SpaceTran will be, adequate freedom to price to meet competition from Arianespace and others, and the level of confidence potential customers have in the reliability of the launch schedule."

The proposed investment plan, described by Mr. Field, is as follows:

"If we do proceed, a major investment, approximating \$1 billion, will be required on SpaceTran's part ... This financing ... is partially dependent upon the economics of the project, but the outline seems clear. Prudential, and possibly others, would make a major equity investment in SpaceTran, but the bulk of the financing would be provided from loans tailored for repayment to match the revenue stream derived from Orbiter V launches."

Mr. Field concluded that Prudential "believes the commercial potential of this magnificent technological achievement can only be fully realized through a marketing entity, with substantial capital at risk, operating outside the constraints of a Government organization. We think it is clearly in the national interest to maximize the resources available to support an expanded commercial space program because the tangible benefits to the Nation are vast, being limited only by the ability of U.S. technology."

"Even though SpaceTran contemplates no Government loan guarantees or subsidies. It is our hope that NASA, the Department of Defense, Members of this Committee and the Congress as a whole would support the SpaceTran proposal and encourage serious discussion between NASA and SpaceTran."

III. MAJOR ISSUES ADDRESSED IN THE HEARING

A hierarchy of issues emerged during the hearing, stemming from the major question before the Subcommittee: "Is a Fifth Orbiter Necessary?" This section addresses these issues starting with a discussion of the need for an additional orbiter, and proceeding with the other issues that emerged: "Who Should Finance the Fifth Orbiter?"; "When Should We Build the Fifth Orbiter?"; "Is Legislation Required In Order for the Private Sector to Assume Ownership and Operation of the Fifth Orbiter?"; and "How Do We Make the Space Transportation System Competitive?". Statements made by witnesses, and excerpts from supporting information supplied by them or their organizations in response to written and oral questions by the Subcommittee, are included in the discussions.

Is a Fifth Orbiter Necessary?

As stated by NASA in a written response to this question: "At the time the new Space Transportation System was approved by the President, the plan was to have five operational Shuttle orbiters and one engineering model." However, this plan has not been implemented, and a question has arisen regarding the need for a fifth operational orbiter. The uncertainty surrounding the Administration's commitment to proceed with a fifth vehicle undoubtedly helped precipitate SpaceTran's proposal to purchase an additional orbiter and market its services.

The need for a fifth orbiter hinges on the predicted use of the Space Transportation System. A "Free World Payload Projections" chart included in NASA's testimony indicates that an average of 55 U.S. launched payloads per year are scheduled in fiscal years 1983 through 1985. Thereafter, the average increases to 61 per year through 1992. The picture is not clear, however, because NASA is supplementing the Shuttle launches at the rate of approximately 12 per year by using the Scout, Delta, Atlas Centaur, and Atlas E/F expendable launch vehicles. Furthermore, the chart did not indicate the number of multiple payload launchings.

It should be pointed out, however, that any discussion of the pre-1988 mission payload profile is meaningless in terms of justifying a fifth orbiter because, in spite of a scheduled peak of 71 payloads to be launched in 1984, as Mr. Culberston testified:

".... it is NASA's belief that we can handle (this launch load) with four orbiters through 1987. In fact, that

is as early as we could get a fifth orbiter if we get it underway immediately; the issue is, therefore, in the years beyond that."

Unfortunately, flight predictions for the years beyond 1987 are less predictable than for the mid-1980s. In response to a question by Mr. Filippo requesting specific launch figures, Dr. Weiss stated, "... we are really seeing ranges in these projections that have been provided to us, in the early 1990s, of about 40 to 50 flights per year."

Mr. Filippo pursued his line of questioning by asking if four orbiters could accommodate 40 flights per year, to which Dr. Weiss replied:

"If we improve the turnaround time to a maximum level we see in that time period, we could probably manage 40 per year...although that would be a very, very thin system, obviously missing one launch capability would cascade downward, as would any of the attrition considerations or downtime that Mr. Culbertson referred to."

This statement reflected the ambiguity of NASA's testimony in general, and conflicted with other testimony where NASA stated that four orbiters would only enable the STS to launch at a peak of 30 flights per year. The Agency would not state that a fifth orbiter was essential, yet NASA expressed concern for future launch schedules in statements by Mr. Culbertson, such as:

"Our position is that through the known and recognized firm mission assignment model that we have, which goes through 1987 and into 1988, we believe that the present four-orbiter fleet can handle the user requirements within reason. On the other hand, as we look downstream at the requirement for orbiter services and in the probable consideration that there is going to be some downtime, NASA believes that it would be very difficult to maintain continuity of flight operations if there are no more than four orbiters."

The following exchange took place between Mr. McGrath and Mr. Culbertson:

Mr. McGrath. "Let me ask you another question. How many orbiters is it going to take in order to reach the 1991 objective of 40 launches per year? Can you do it with four?"

Mr. Culbertson. "Sure. As Dr. Weiss said, if there is no attrition and no significant downtime, we believe we can launch 40 flights in 1991."

The assumptions that there will be no attrition or downtime are tenuous, and the NASA representatives were pressed on the potential impact to launch schedules that could ensue

if one orbiter was lost. The effect of such a loss would be felt mainly by the civil and commercial sectors of the user community since in a written response to a Subcommittee question, NASA stated that:

"Our present orbiter utilization plans assume that one orbiter would be predominantly utilized for West Coast launches. The loss of one of the remaining three orbiters would leave two orbiters available to meet East Coast launch requirements. Based on the priority assigned to the launch of national security missions, the desired launch dates of the lower priority civil missions might not be met, particularly if the forecast increases in launch demand exceed the projected three-orbiter fleet launch capability of 18 to 21 flights per year. Under such circumstances, it is likely that commercial customers would have to use expendable launch vehicles (domestic or foreign) to be assured of timely launch service."

The clear implication here is that civil launches would be the first to slip or be cancelled if the present orbiter fleet was adversely affected in size or availability. This point was emphasized by Mr. Aldridge, who presented the DOD position at the hearings. Contrary to NASA's cautious position, the DOD was more positive in backing a fifth orbiter. Mr. Aldridge said:

"We believe a five-orbiter fleet is required to support our national commitment to the Shuttle and support the launch requirements of a multiplicity of users, of which the Air Force is one."

"While the Department of Defense can satisfy its own requirements with a four-orbiter fleet based upon the established priorities, we believe the risks in such a program are unacceptable to the Nation due to the possibility of orbiter attrition or the possibility and problems with orbiter turnaround to meet our mission requirements."

Mr. Aldridge raised other concerns regarding Shuttle performance requirements: the need to preserve an engineering team to factor in design changes; and the fact that more than five orbiters may be necessary after additional operational data have been evaluated. DOD's position on the need for a fifth orbiter can be summarized by quoting directly from Mr. Aldridge's prepared statement before the Subcommittee:

"- Regardless of the assumptions made on turnaround, the Shuttle system cannot tolerate orbiter attrition or extended downtime for overhaul or repair without significant operational impact."

- "- The four to six year delay to replace an orbiter would severely disrupt both the military and civil space programs.
- "- Only two of the four orbiters are the lightweight, fully capable orbiters required for certain missions.
- "- Additional operational experience will certainly indicate design changes which could result in improved capability.
- "- While not now estimated to be a near term problem, orbiter wear out is an eventual certainty either from structural fatigue or from technological obsolescence.
- "- And, finally, the orbiter production team is a valuable and unique asset that will disappear if the line stops at four orbiters.

"When these considerations are factored into the decision, we believe that the orbiter production line should be maintained and that additional orbiters should be procured. Specifically, we support the procurement of a fifth orbiter and the provision for additional procurements, as needed."

Similar support for a fifth orbiter was given by Dr. Grey. The basis for his support came from an AIAA report that was released on January 19, 1981. He summarized the report's conclusions as follows:

"...the projected space transportation system capacity, by itself, will be unable to meet projected user demand through at least the latter portion of the 1980's, and that is even if none of the highly advanced technology missions that we had projected might occur; that is, space processing, some of the large-structure requirements, and so on. It was our judgement, however, that some of that demand will develop and therefore exacerbate the situation even further.

"The second point was made that operational problems are certain to be encountered...It would be nice if we were able to meet our turnaround specifications, and it would be nice if we didn't have any severe anomalies that might delay orbiters or lose an orbiter, but we know, based on our past experiences, that it is likely that such anomalies will happen."

In his written statement to the Subcommittee, Dr. Grey expressed his concern that since the AIAA had completed its study, the demand for space launches has exceeded the study's projections and in answer to a written question, Dr. Grey stated that "... the presently planned four-orbiter fleet is not sufficient to meet projected demand, and hence that a fifth orbiter should be ordered..."

Additional private sector support for a fifth orbiter was implicit in the testimonies of the Boeing Aerospace Company, and Space Transportation Co. Inc. Dr. Brock described a Boeing study, completed in January 1979, whose "objective was to investigate in a preliminary way the attractiveness of Space Shuttle operations as a business venture." Using NASA's 1977-78 traffic forecasts and pricing policies, and assuming the purchase of a fifth orbiter, Boeing's study concluded that, "private operation of the Space Shuttle system can be commercially rewarding", but added the warning that, "data to support this conclusion are, at this moment, not conclusive."

The main point in regard to this testimony is that Boeing's findings indicated an attractive return on investment using a five-orbiter fleet. Dr. Heiss believes that it would be commercially profitable for a company to purchase and operate even one orbiter (the fifth). In responding to a question from Mr. McGrath, Dr. Heiss said:

"...we have identified a specific commercial and foreign market which needs, in capacity, 20 to 25 percent of the total fleet of five orbiters. We are saying that the private sector fund that capacity represented by the fifth orbiter and accommodate that demand with commercial principles in marketing the system and financing launches."

In evaluating the testimony given on the need for a fifth orbiter, it may be said that each of the five participating organizations, from both the public and private sectors, believe that a fifth orbiter is required. NASA is still studying the need, but is obviously concerned about orbiter attrition and turnaround times, although constrained to deny this concern; Dr. Grey's observations indicate that NASA's mission profile is understated; DOD sees no problem in satisfying its own needs with a four-orbiter fleet, but adamantly supports a fifth Shuttle in answer to the Nation's commercial and civil government needs; while Boeing and SpaceTran studies, respectively, assume a fifth orbiter, and predict its need for commercial applications.

Who Should Finance the Fifth Orbiter?

The witnesses represented a mix of government and private sector officials; thus, their testimony was helpful in clarifying the issue, who should finance the fifth orbiter?

Congressman McGrath summarized his beliefs on this issue:

"...frankly, (first) I think we need a fifth orbiter. (Second), I think the Government ought to pay for it. (Third), I don't think that we should have private enterprise pay for it unless I can be convinced with sound fiscal and policy arguments."

SpaceTran President, Dr. Heiss, stated that when the "...private sector is technically and financially capable of providing its resources to operate a program, the policy of the Government in the past has been to permit private enterprise to engage in such activities. The SpaceTran proposal follows that precedent.

"Private investment in the Space Transportation System is possible only if the expected return justifies the risk of the investment...Since SpaceTran is not seeking any exclusive uses or exclusive arrangements with the U.S. Government, demonstration of demand may well lead to added private competition in the very field chosen by SpaceTran... This is the investment risk determination it must make and is the type of decisions made by U.S. companies constantly."

Mr. Aldridge said, in regard to the DOD position on who should finance the fifth orbiter, "We support a fifth orbiter funded through NASA as a necessary element of the National (Space Transportation System) requirement."

Following repeated questioning by various Subcommittee Members about why the DOD would not fund a fifth Space Shuttle, or pick up a larger share of the Space Shuttle procurement cost, Mr. Aldridge testified that: "... The Air Force 'share' of the Shuttle development funding was determined by its share of the development responsibilities. Our contribution to the Shuttle program development (notably Vandenberg, the Inertial Upper Stage, the Consolidated Space Operations Center and payload transition to the shuttle) represents a financial contribution approximately equal to the Air Force use of the Shuttle system. The Air Force 'share' of the operations cost is determined by a jointly negotiated pricing policy between NASA and DOD. In that policy, the DOD is credited with the manpower it must employ (with no repayment)

toward the operation of the Vandenberg launch site for all users (civil and military). In return DOD does not reimburse NASA for the NASA manpower at Kennedy and Johnson (Space Centers) which support DOD launches, but does pay the same cost as any other user for the hardware used in the Shuttle launch."

Mr. Aldridge further qualified his position that: "If it was an agreement at that time that the Administration and the Congress... had put the money in the DOD budget for buying orbiters, we would have been buying orbiters today... If we found any reason why there is a dedicated need and a unique need for DOD to pay for one of the orbiters, we would certainly fund it. But right now we believe that NASA ought to fund the fifth orbiter as part of the original agreement."

The Boeing Aerospace Company studied private sector operation of the STS in 1979. Dr. Brock summarized this effort:

"The Boeing concept envisioned private sector assumption of a given segment of the market on a franchise basis for a limited period of time.

"(Our concept) included the purchase by the private sector of a fifth orbiter."

Dr. Heiss testified that it is in the national interest to "spinoff" government developed technologies to the private sector:

"Two very significant studies have been made. One is Project Redcap in the mid-1970s, a joint study by the Department of Defense, NASA, and the Department of Transportation, which showed that 90% of all major advances in aeronautics from 1925 to 1972 were government funded and sponsored.

"Also, from 1966 to 1977, 82% of all applied aerospace R&D was funded by the Federal Government and not recouped.

"In addition, the National Transportation Policy Study, which looked to the past and the future, pointed out that the total funding of applied--applied, not basic--research and development in aerospace, just from 1970 to 1979, was \$60 billion, none of which is recovered.

"SpaceTran proposes to follow this successful policy established over the past 50 years. I do not think an exception should be made in the case of space industrialization; rather, I think we should set a precedent to follow past history, and in that case, I think space industrialization, not just Orbiter V funding, can and will be successful."

Who should finance the fifth Space shuttle? The Department of Defense states that NASA should procure the fifth orbiter, since this was part of the original NASA/DOD agreement; NASA testified that a four orbiter fleet will be adequate to meet the space traffic requirements until the late 1980s, and if a decision is subsequently made to procure a fifth orbiter, NASA should procure this vehicle.

Mr. Culbertson provided additional information regarding NASA's position in the following exchange with Mr. McGrath:

Mr. McGrath. "Is it fair to say that if a decision had been made at this time for a fifth orbiter and some money toward that orbiter had been appropriated, that there would be little or no policy decision to be made about private enterprise getting into the business of NASA and the Air Force? Would you have ever entertained a proposal such as Space-Trans?"

Mr. Culbertson. "In the first place, I doubt that we would have received the proposal because it was in recognition of the problem that the Government was facing in making up its mind about what to do. I guess I feel that the normal fiscal process within the Federal Government is pretty well established as an effective way to proceed. We have our lumps once in a while and we have our difficulties, but the present procurement process probably continues to be as good a model of the Government's funding this type of activity as any one that I could propose."

Mr. McGrath. "In other words, you do not believe that there would have been a proposal."

Mr. Culbertson. "I told you what my guess would have been, but my response has to be that certainly it is a different environment when the Government is not funding its own orbiter. I would believe that there would have been relatively little incentive to have given favorable consideration to the proposal had we had the orbiters under contract."

While Boeing testified that they had previously studied private operation of the STS in 1979, the company was unwilling to commit to a financial commitment of an untried system. The Boeing concept was similar to SpaceTran's since the company would purchase the fifth orbiter; however, initially a portion of the STS market would be operated on a franchise basis. This would have minimized corporate risk.

When Should We Build the Fifth Orbiter?

All of the witnesses agreed that the fifth orbiter is necessary for a national commitment to a Space Transportation System that will meet both civil and national security launch requirements. Members of the Subcommittee are concerned that a timely decision must be made, so that the price of the orbiter will not increase substantially. Congressman Hollenbeck stated:

"I have learned that the Space Shuttle third tier subcontractors have completed work for orbiter 104, and without a commitment for a fifth Shuttle, many of these companies will either go out of business or move on to other work. We all realize what this means: Either commit now to an additional orbiter for \$1 billion, or be willing to pay at least \$2 to \$2.5 billion later on down the road."

Mr. Culbertson described the current status of Space Shuttle production and contractor work:

"OV-99 (Challenger) was delivered from its Palmdale assembly facility to the Dryden Flight Research Facility (DFRF) on July 1, 1982. From there, it was transported atop the 747 carrier aircraft to Kennedy Space Center (KSC) for its first use on STS-6. OV-103 (Discovery) is now in the initial stages of final assembly. Some major structural elements have been delivered to Palmdale including the mid-fuselage, wings and lower forward fuselage. Other major structural elements and subsystems are well along in manufacture... OV-103 is planned for delivery in September 1983. Detail parts manufacturing and structural assembly build-ups are underway for OV-104 (Atlantis) with the mid-fuselage scheduled to be delivered in 10 months. OV-104 is the last of the approved four-orbiter fleet and upon completion of its various elements and subsystems, the orbiter production facilities will begin to shut down. OV-104 is planned for delivery in December 1984.

"Most second and third tier subcontractors are still in place as they continue to complete their work on OV-104; however, some subcontractors' work force are already beginning to be taken off the program and by late this year and early next year a number of the second and third tier contractors will run out of work."

In previous fiscal years, the Space Science and Applications Subcommittee had authorized the monies to initiate procurement of long lead items for a fifth orbiter. NASA repeatedly chose to ignore the wishes of Congress, thus as late

as FY 1982 there were no long lead procurement actions taken by NASA for OV-105. However, for FY 1983 Mr. Culbertson described how NASA "... requested \$90 million for the fifth orbiter in our original position with OMB." The FY 1983 Administration request for NASA did not contain the funding provision for OV-105.

FY 1983 is a critical year in which the fifth Space Shuttle decision must be made. As previously mentioned, subcontractors will soon complete Shuttle-related work. This reduction in the subcontractor work force will only mean an increase in the fifth orbiter production costs and a delay in its delivery date. Chairman Filppo pursued this issue further in the following exchange:

"Can you ... tell me when a decision for a fifth orbiter must be made in order to avoid these gaps and significant cost increases?"

General Abrahamson. "In some respects, we are already beginning to see some of these gaps develop, or at least we are beginning to see some of the subcontractors' manpower and workforce begin to be taken off the program."

Mr. Filppo. "How much would any production gap affect the price of additional orbiters?"

General Abrahamson. "I believe that we are talking between 20 and 25 percent; and that is not a constant. Some production gaps would not be such a major impact to NASA; others would result in losing some subcontractors and then either having to go out and develop a new subcontractor, which would mean requalifying that particular manufacturer."

It was the consensus of the witnesses that further delays in the procurement of the fifth orbiter would result in an increase in acquisition costs.

Is Legislation Required In Order for
the Private Sector to Assume Ownership and Operation
of the Fifth Orbiter?

The Subcommittee is expressly concerned that Congress be informed of any move to transfer the Space Transportation System to the private sector.

Dr. Heiss testified that legislation would not be required for the transfer; however, Congressional review would be beneficial:

"It appears, based on legal analysis, that NASA has the requisite legislative authority to enter into such (an) agreement (with SpaceTran) and to perform the functions that such an arrangement contemplates. An endorsement of the concept from the Congress or its appropriate Committees would be helpful and we will welcome full review by Congress of whatever Cooperative Agreement we reach with NASA."

Mr. Hollenbeck stated that the SpaceTran transfer might conflict with the "Anti-Deficiency Act", which states:

"No officer or employee of the United States shall make or authorize an expenditure from or create or authorize an obligation under any appropriation or fund in excess of the amount available therein; nor shall any such officer or employee involve the government in any contract or other obligation, for the payment of money for any purpose, in advance of appropriations made for such purpose, unless such contract or obligation is authorized by law."

In particular:

"No advance of public money shall be made in any case unless authorized by the appropriation concerned or other law."

In response to Mr. Hollenbeck's concern that the "Anti-Deficiency Act" would stop any serious consideration of a proposal like SpaceTran's, Mr. Dembling, a partner in the law firm of Schnader, Harrison, Segal and Lewis who accompanied SpaceTran and Prudential to the witness table, commented that legislation would not be required: "... we view the conceptual proposal that we submitted to NASA as not requiring legislation. In a review of the NASA Act of 1958 we have determined that NASA has all of the authority necessary to perform the functions contemplated by the May 1982 proposal that we submitted to NASA."

How Do We Make the Space Transportation System Competitive?

A recurring issue throughout the hearing was, how do we make the STS competitive? In light of the foreign government-subsidized Ariane, NASA may find potential Space Shuttle users being drawn away for the reasons described by Mr. Culbertson:

"For the period 1983-1985, the Shuttle price is cheaper than Ariane even when the Ariane financing terms are considered. However, the number of Shuttle flights projected for

this period of time was not able to meet some of the customers' schedule requirements. Ariane could meet some of their schedule requests.

"Further, Ariane has offered an increased performance of several hundred pounds to geosynchronous orbit over that which the Shuttle and the SSUS-D can provide. This improved performance provides an opportunity for a payload user to extend orbit life time an additional 1 1/2 to 2 years which is worth millions of dollars in revenues. NASA and McDonnell Douglas are reviewing options to provide equivalent increases in performance.

"I think it is clear that Ariane is going to be a keen competitor with United States launch services ... we see potential users, primarily in the communications satellite world, who are left to choose between Ariane and Shuttle have, for one reason or another, elected Ariane ... the principal reason being that they see the Shuttle manifest is very full in the time that they want to fly."

Commercial users are also concerned that DOD priorities may bump their payloads since, as Mr. Aldridge described: "the DOD requirements are currently for 118 launches of the total 312 Shuttle launches projected by NASA through 1994." Approximately one-third of all Space Shuttle missions will be dedicated to the DOD, and these missions have priority over any commercial users.

Dr. Grey testified that a new, more realistic pricing structure should be implemented to make the STS more competitive. "I imply not only total price, but also terms of payment. Ariane's price is certainly higher than that charged to commercial Shuttle customers, but Arianespace's terms are far more favorable. There are a number of innovative pricing policies which could bring both a higher long-term return to the U.S. taxpayers and still be quite competitive with foreign launch services. One suggestion I have made in the past is simply to charge a royalty on all revenues (or a higher royalty on profits) generated by a customer's satellite, asking him to pay only a small 'earnest-money' fee up front. If commercial revenues indeed grow as the AIAA has projected, the total launch-service income would far exceed that obtainable with present pricing policies, and yet the royalty payment basis would be highly attractive to commercial customers because they would pay only out of revenues or profits."

Mr. Brock stated that "effective Shuttle competition is based on price, terms, and reliability of launch as well as ability to carry larger loads. The flexibility of Shuttle operation makes it attractive. Payloads can be checked out in orbit before release. However, the bottom line is the cost per pound in the desired orbit, and this has to be no higher than Ariane if the Shuttle is to be competitive."

Dr. Heiss testified that a private company, like SpaceTran, could help make the STS more competitive:

"...any private entity with substantial money at risk, can utilize certain marketing techniques not available to a government entity. Advantages of private marketing include a competitive pricing policy reflecting financing capability and the possibility of joint ventures with potential users. SpaceTran intends to follow an active marketing approach similar to that pursued by Arianespace, which itself is a commercial and private entity.

"The Space Shuttle can compete with Ariane once commercial and other non-United States Government (USG) users have confidence in the Shuttle capabilities, particularly launch schedule reliability. The competitive position of the Space Shuttle system will substantially improve with an orbiter dedicated to such non-USG uses. In addition, financing and joint venture arrangements with potential Shuttle users and payload investors will increase the range of competitive markets of the Shuttle versus the European system. In our view, a private entity for the marketing, contracting, and financing launches is warranted to make the Space Shuttle a commercial success. This is all the more so when the company has substantial funds at risk. This is the SpaceTran concept."

A particular advantage to private marketing of STS payloads would be the range of services that the private sector could provide. One example is payload contract servicing, as described by Dr. Heiss:

"SpaceTran hopes that it can simplify the contracting for space launch services by becoming a 'single stage' marketing and contracting entity. SpaceTran plans to offer launch services assistance in connection with payload requirements, and assistance for launch insurance, payload integration services, and other related services."

All of the witnesses agreed that the Ariane may become a keen competitor to the STS; however, there are a number of ways in which the STS can remain competitive. As described by Dr. Grey, alternatives to the current NASA pricing policy must be investigated. It is not clear that a "fly now, pay later" policy should be implemented; however, more attractive financing and payment schedules would make revenue-conscious satellite users consider the STS over Ariane.

Finally, only in the future operations of the Space Shuttle will commercial and foreign users of the STS be able to evaluate the accuracy of the Shuttle payload manifest, and determine how often DOD payloads will bump private payloads.

IV. CONCLUSIONS AND RECOMMENDATIONS

After reviewing the testimony, the following conclusions are offered by the Subcommittee:

CONCLUSION NO. 1

A fifth Space Shuttle orbiter will be required in order to meet projected launch requirements for the late 1980s. The currently funded four-orbiter fleet may eventually be able to support 24 launches per year; however, the projected manifest of 40 launches per year could only be accomplished by a flawless, four-orbiter fleet continually operating at maximum efficiency. Any anomalies in turnaround time, launch schedule, Shuttle processing, etc., would probably make it impossible to achieve 40 flights per year.

CONCLUSION NO. 2

A limited orbiter fleet size in concert with the launch priority afforded defense and national security payloads threaten to preempt civil and commercial payload launches thereby strengthening the competitiveness of foreign launch vehicle systems.

CONCLUSION NO. 3

Third tier Shuttle orbiter subcontractors have begun to run out of Shuttle-related work. Further delays in procurement of the fifth orbiter vehicle will result in a loss of the subcontractor base with the consequent cost penalties associated with restart and requalification.

Recommendation: NASA should initiate procurement of the fifth orbiter vehicle in fiscal year 1983 to assure a launch rate capability for mission requirements in the late 1980s and to avoid the cost penalties associated with a longer production gap.

CONCLUSION NO. 4

Witness testimony related to the proposal for private financing of the fifth orbiter vehicle was insufficient to judge the merits of the concept at this time.

CONCLUSION NO. 5

The Subcommittee expects to conduct a full public review of any agreement which would provide for private funding and ownership of a fifth orbiter vehicle.

Recommendation: NASA should expeditiously complete an evaluation of the SpaceTran proposal and report its findings along with any recommended legislation to the Congress.

CONCLUSION NO. 6

NASA must become more "customer oriented" to sustain and increase the market for Shuttle usage.

Recommendation: NASA should continue to encourage more active involvement and investment of the private sector in civil space activities. NASA should seek greater private sector participation in Space Shuttle marketing activities.